Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

rve
9
772Ht

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils
and Agricultural Engineering

H. T. & S. Office Report No. 230

LIBRARY
SERIAL RECORD
OCT 11 1950
U. S. DEPARTMENT OF AGRICULTURE

Refrigerator Car Preheating Tests Comparing Alcohol, End Bunker Charcoal and Underslung Charcoal Heaters, Grand Forks, North Dakota. February and March, 1950

By

J. M. Lutz, Senior Physiologist
Vincent Reubelt, Biological Aid
Herbert Findlen, Associate Horticulturist
A. D. Edgar, Senior Agricultural Engineer

Division of Fruit and Vegetable Crops and Diseases
Division of Farm Buildings and Rural Housing.

East Grand Forks, Minnesota
Spetember 5, 1950

Preheating Tests Comparing Alcohol, End Bunker Charcoal and Underslung Charcoal Heaters. Grand Forks, North Dakota. February and March, 1950.

Preheating of cold refrigerator cars for shipment of potatoes during the winter months is an important problem in the Red River Valley. Due to the severe cold in this section, it is not uncommon to have inside car temperatures of minus 20°F. or below. This necessitates preheating the cars prior to loading to an inside temperature of about 40°F. above zero.

The object of this test was to determine the relative efficiency of alcohol, end bunker charcoal and underslung charcoal heaters in preheating cars during very cold weather.

EXPERIMENTAL EQUIPMENT AND PROCEDURE

Five cars were used in Test I and four in Test II. The list of cars together with the heaters used were as follows:

Car No.	Type of Heater	Used in Test
A-IC 50437	Underslung-Charcoal	I and II
B-IC 50470	End Bunker - Alcohol	I and II
C-IC 50441	End Bunker - Charcoal	I and II
D-BRE 74399	Underslung - Charcoal	I and II
E-BRE 74398	End Bunker - Charcoal 1/	I

The cars were spotted on an East-West track in Grand Forks, North Dakota and were not moved during the duration of the two tests.

TEST CARS

Just previous to making these tests all of these cars had been used on a banana test from New Orleans, La. to Winnipeg, Canada. (H.T.&S. office Report No. 226). They were all 40' end bunker fan cars, the I.C. cars having 3-3½" of insulation and the BREX cars having 4-4½". The floor racks were covered with manila paper, except at the doorway where a space of about 12 inches was left uncovered. This is standard procedure followed by the Western Fruit Express Co. in preparing cars for potatoes during the winter.

HEATERS

The Luminator-Mitchel underslung charcoal heater has been fully described in the banana report. In general, it consists of a heater mounted underneath the car which contains a heating coil that is connected to a pipe coil which runs underneath the floor rack of the car. These coils contain a mixture of water and ethylene glycol. The heaters were operated by manual control at the widest draft opening. In Test I, the ashpit door was closed. In Test II this door was replaced by a

1/ This car equipped with underslung heaters but used as an end bunker heated car in this test.

screen in car D. to secure faster burning. The underslung heaters were on the north side of the cars in these tests.

Simplex heaters were used for the end bunker charcoal heaters, one being placed in each bunker.

Preco alcohol heaters with the thermostat set at 60°F. were used for end bunker alcohol heaters, one being placed in each bunker.

TEMPERATURES

Twelve air temperatures were obtained in each car by means of distance reading resistance thermometers. The positions in which they were placed were as follows:

Position	Designation
Bottom bunker, center line and north side	BBCL, BBNS
Top bunker, north side	TBNS
Bottom quarter length, center line and north side	BQCL, BQNS
Top Quarter, north side	TQNS
Bottom doorway, center line and north side	BDCL, BDNS
Middle doorway, north side	MDNS
Top doorway, north side	TDNS
Liquidometer positions, top and bottom	TL, BL

All of the positions were on the west end of the car except for the liquidometer positions which were near the doorway towards the east end. The top positions were all 12 inches from the ceiling except the liquidometer position which was at the ceiling. The bottom positions were all resting on the paper covering the floor racks.

In addition to the resistance thermometer readings, inside wall temperatures were obtained by fastening thermocouples to the inside wall on the north side of the cars on the west end, 5 feet from the doorway and 14 inches above the floor racks.

TEST PROCEDURE

TEST I

The doors and vents of the cars were kept open for 24 hours prior to the start of the test so as to thoroughly cool the cars. The minimum temperature during this 24 hour period was minus 32°F. and the maximum was minus 12°. The doors and vents were closed and the heaters lit February 25 at 10:30 AM when the test was started. Temperature records were taken at the intervals shown in the upper part of tables 1 to 5 inclusive. Readings were continued for 1 day after the heaters were darkened to determine temperature changes that occurred in the cars after the heaters were darkened.

TEST II

Immediately after the completion of Test I on February 28 at 9:00 AM, the doors and vents were opened to cool the car down. They were closed the following day at 5:00 PM when the readings for Test II were started. The heaters in this test were lit at 10:00 PM. The main purpose of this second test was to determine the rate of heating of an underslung heater car (car D) with the ash door replaced by a screen to secure faster burning since the rate of heating in the underslung cars in Test I with the ash door closed was slow. Temperature records were taken at the intervals shown in the lower part of tables 1 to 4.

DISCUSSION OF RESULTS

TEST I (Feb. 25-28)

The air temperatures in the cars are given in the upper part of tables 1 to 5 inclusive and the comparative rate of heating of 3 of the cars is illustrated in figure 1.

Although the underslung heaters gave the most uniform temperatures throughout, heating was not so rapid in these cars. Table 6 gives the time required for all the bottom positions and the average of the bottom temperatures to reach 40°F. It required 47 hours from a starting temperature of around minus 20° for the average bottom layer temperature to reach 40° (which would be considered a minimum safe temperature for loading potatoes) in car A which was equipped with an underslung heater. In the comparable end bunker charcoal heater cars it required an average of 27 hours and for the alcohol heater car, 30 hours.

The time required for all positions on the floor of the car to reach 40°F. was: in the underslung heater cars over 48 hours; for the alcohol heater car 36 hours; and for the end bunker charcoal heater cars an average of 29 hours.

After the heaters were darkened, the temperature in the alcohol heater car started to drop immediately. However, the temperature was high enough so that the bottom layer average temperature was still 35.8° F. 24 hours after the heater was extinquished. The average bottom layer temperature in the end bunker charcoal cars was well above 40°, 24 hours after darkening while in the underslung heater cars the average bottom layer temperature had dropped to about 29°. In darkening the heaters in the end bunker charcoal heater cars the cut off slide was closed, resulting in 8 to 10 hours further burning of the heaters thus accounting for the lag in temperature drop in these cars. The weather had moderated considerably during the period following the darkening of the heaters.

It should be pointed out that these cars were new and well insulated. The probability is that older cars in poorer condition would not heat up so rapidly nor hold the heat as well.

TEST II (Mar. 1-3)

The air temperatures for this test are given in the lower parts of tables 1 to 4 inclusive and the comparative rate of heating of the cars is illustrated in Figure 1. The time required to bring all positions on the floor and the average bottom layer temperatures to 40° are given in table 6. As in the previous test, preheating was slow in the underslung car with the ash pit door closed (car A). Replacing the ash pit door with a screen speeded up the rate of burning of the underslung heaters so that this car (car D) warmed up nearly as fast as the alcohol and end bunker charcoal heater cars (cars B and C). In this second test, rate of heating was fastest with the end bunker charcoal heaters as was true in Test 1.

FUEL CONSUMPTION

The fuel consumption for the 2 tests are given in table 7. As was found in the banana test, fuel consumption for the charcoal heaters was less in the end bunker than in the underslung.

COMPARISON OF LIQUIDOMETER AND RESISTANCE THERMOMETER READINGS

Table 8 gives the air temperatures obtained with the liquidometers compared with those obtained with resistance thermometers in similar locations. In general, the liquidometer and resistance thermometers were in close agreement except in the bottom position in car E where the liquidometer readings were appreciably lower than the resistance thermometer readings. Since this liquidometer was apparently reading correctly in the banana test, a possible explanation is the position of the bulbs. The liquidometer bulbs were below the floor racks while the resistance thermometer bulbs were resting on the paper covering the floor racks. In this car which was heated with end bunker heaters there could have been considerable temperature lag below the floor racks while the heaters were burning. After the heaters had been darkened 24 hours, the bottom resistance thermometer and liquidometer readings in this car were identical. Because of the nature of the operation of the two types of equipment, the resistance thermometers are more responsive to rapid changes in temperature than the more bulky liquidometer bulbs which is illustrated in the data in Table 8.

SUMMARY

Underslung heaters with the ash pit door closed (normal operation) were slow in prewarming cold cars. Fastest preheating was obtained with end bunker charcoal heaters although alcohol heaters were nearly as rapid. Replacing the ash pit door with a screen in the underslung heater accelerated the rate of burning resulting in nearly as rapid preheating as with the end bunker heaters. It should be noted that cars preheated by portable charcoal heaters will require ventilation prior to loading to eliminate the effects of toxic gases on loading personnel. This will result in a considerable loss of heat as compared to a car preheated by the underslung heater, which can remain burning during loading. It is therefore believed that the slightly slower heating rate of the underslung heater would be more than offset by its ability to remain burning during loading with no heat loss due to airing out the car.

Fuel consumption was slightly less in the end bunker charcoal than in the underslung heaters under the conditions of this test.

Liquidometer readings were generally the same as resistance thermometer readings located in the same position except at the bottom position of an end bunker heated car where the difference might have been due to the placement of the resistance thermometer bulb.

ACKNOWLEDGEMENTS

These tests were made possible by the following individuals and companies whose cooperation and assistance is gratefully acknowledged:

Mr. Keith Erickson, general agent of the Western Fruit Express Co., Grand Forks, North Dakota, for preparing the cars and heaters for the tests, for servicing the heaters during the tests, and for obtaining the fuel consumption records;

The Illinois Central and CB&Q Railroads for furnishing the test cars;

Mr. J. E. Ballard of the Illinois Central Railroad and Mr. Henry Meinhardt of the CB&Q Railroad for making the cars available and suggesting some of the test procedures.

Table No. 1

Corrected Air Temperatures

Car No. A IC 50437
HEATER-UNDERSLUNG CHARCOAL-ASH DOOR CLOSED BOTH TESTS.

Date	Time	OST °F.	Wind	BBCL	BBNS	TBNS	BQCL	BQNS	TQNS	BDCL	BDNS	MDNS	TDNS	TL	BL	MAX.	MIN.	AVE. TOPS	AVE. BOTT.	LIQUID-OMETER TOP	LIQUID-OMETER BOTT.	INSIDE WALL
											Test I.											
Feb.																						
25	10:00A	-19	Calm	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-21
	10:30A										Heaters Lit											-21
	1:00P	-4	SSW8	-1/	-1/	-1/	-1/	-9	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-9	-1/	-1/	-	-1/	-1/	-
	2:00P	0	SSW6	-1/	-1/	-1/	-1/	-6	-1/	-1/	-8	-1/	-8	-10	-1/	-6	-1/	-	-	-1/	-1/	-
	3:00P	2	SSW6	-1/	-1/	-8	-1/	-3	-7	-1/	-4	-8	-4	-7	-1/	-3	-1/	-6.5	-	-10	-10	-
	5:00P	1	SSE7	-7	-9	-3	-7	2	-2	-7	-1	-4	1	-2	-8	2	-9	-1.5	-5.3	-6	-7	-
	8:00P	-12	SSW9	-2	0	5	1	9	6	1	7	4	9	6	-1	9	-2	6.5	2.1	2	0	7
26	12:45A	-16	SSE8	9	9	13	10	19	13	8	18	11	17	15	8	19	8	14.5	11.6	8	8	-
	9:00A	-9	SSE19	11	11	14	13	19	14	12	19	13	19	15	12	19	11	15.5	13.9	13	14	17
	4:10P	17	SSE20	21	20	25	23	29	27	23	30	24	31	27	22	30	20	27.5	24.0	24	22	29
27	9:30A	17	SSE30	36	39	39	40	43	40	40	45	38	45	41	38	45	36	41.2	40.1	37	37	41
	10:00A										Heaters darkened											
	4:30P	30	SSW15	35	32	37	35	37	37	36	38	36	43	37	35	43	32	38.5	35.4	37	36	-
	9:15P	25	WNW20	35	32	35	35	36	36	35	35	35	42	36	34	42	32	37.2	34.6	36	36	-
28	9:00A	10	W 40	29	27	29	30	30	29	30	30	28	36	30	30	36	27	31.0	29.4	30	32	-
											Test II											
Mar.																						
1	5:00P	-2	NNW20	1	-2	0	1	1	2	1	3	2	-	3	4	4	-2	1.7	1.3	5	6	
	10:00P	-12									Heaters lit											
2	9:00A	-15	SSE9	13	15	17	16	22	17	16	19	16	-	18	17	22	13	17.3	16.9	16	18	
	4:30P	4	SE 16	23	21	27	25	31	28	25	28	26	-	29	26	29	21	28.0	25.6	26	26	
3	9:00A	12	SE 19	29	28	33	31	37	33	31	34	32	-	34	32	37	28	33.3	31.7	32	34	

1/ Colder than minus 10°F., lowest point on instrument.

Table No. 2

Corrected Air Temperatures

Car No. B IC 50470
HEATER-ALCOHOL

Date	Time	OST °F.	Wind	BBCL	BBNS	TBNS	BQCL	BQNS	TQNS	BDCL	BDNS	MDNS	TDNS	TL	BL	MAX.	MIN.	AVE. TOPS	AVE. BOTT	INSIDE WALL
Feb.										Test I										
25	10:00A	-19	Calm	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-20
	10:30A									Heaters Lit										-20
	1:00P	-4	SSW8	-1/	-1/	7	-1/	-4	-1/	-1/	-1/	-2	3	2	-1/	7	-1/	-	-	-
	2:00P	0	SSW6	-10	-9	12	-10	0	-1/	-1/	-9	2	8	6	-1/	12	-1/	-	-	-
	3:00P	2	SSW6	-6	-4	17	-6	5	-7	-7	-4	7	12	11	-1/	17	-1/	8.2	-	-
	5:00P	1	SSE7	2	4	27	2	15	2	0	4	16	21	20	-5	27	-5	17.2	3.1	-
	8:00P	-12	SSW9	11	14	37	12	25	12	10	14	26	32	30	2	37	2	27.8	12.6	17
26	12:45A	-16	SSE8	18	20	45	20	34	19	18	21	31	39	37	12	45	12	35.0	20.4	-
	9:00A	-9	SSE19	28	29	55	29	44	29	27	29	38	47	45	21	55	21	44.0	29.6	31
	4:10P	17	SSE20	38	40	63	38	55	39	35	40	48	57	56	31	63	31	53.8	39.6	43
27	9:30A	17	SSE30	56	58	71	56	73	57	55	57	62	68	67	51	73	51	65.8	58.0	57
	10:00A									Heaters darkened										
	4:30P	30	SSW15	49	49	53	49	-	49	48	48	51	52	52	45	53	45	51.5	48.0	-
	9:15P	25	WNW20	45	45	47	46	-	45	45	45	-	47	47	42	47	42	46.5	44.7	-
28	9:00A	10	W 40	35	35	36	36	-	35	37	35	37	36	37	37	37	35	36.0	35.8	-
Mar.										Test II										
1	5:00P	-2	NNW20	0	1	1	1	-	0	1	1	2	2	3	4	4	0	1.5	1.3	
	10:00P	-12								Heaters Lit										
2	9:00A	-15	SSE9	22	24	45	24	-	24	26	24	31	42	42	22	45	22	38.2	23.7	
	4:30P	4	SE16	34	36	59	35	-	35	38	37	46	56	55	32	59	32	51.2	35.3	
	9:00A	12	SE19	49	51	72	51	-	51	54	51	59	68	69	47	72	47	65.0	50.5	

1/ Colder than minus 10°F., lowest point on instrument.

Table No. 3

Corrected Air Temperatures

Car No. C IC 50441
HEATER-END BUNKER CHARCOAL

Date	Time	OST °F.	Wind	BBCL	BBNS	TBNS	BQCL	BQNS	TQNS	BDCL	BDNS	MDNS	TDNS	TL	BL	MAX.	MIN.	AVE. TOPS	AVE. BOTT	INSIDE WALL
Feb.										Test I.										
25	10:00A	-19	Calm	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-20
	10:30A									Heaters Lit										-20
	1:00P	-4	SSW8	-8	-9	7	-10	-5	11	-6	-4	1	7	-	-7	11	-10	8.3	-7	-
	2:00P	0	SSW6	-3	-4	13	-6	0	16	-2	0	5	13	-	-1	16	-6	14.0	-2.3	-
	3:00P	2	SSW6	1	1	17	-2	5	20	3	6	9	17	-	3	20	-2	18.0	2.4	-
	5:00P	1	SSE7	8	9	19	6	12	27	12	13	17	25	-	11	27	6	23.7	10.1	-
	8:00P	-12	SSW9	17	17	31	14	18	32	21	21	25	33	-	19	32	14	32.0	18.1	21
26	12:45A	-16	SSE8	23	23	37	22	25	41	27	28	31	38	-	25	41	22	38.7	24.7	-
	9:00A	-9	SSE19	28	29	41	28	28	41	31	30	33	43	-	30	43	28	41.7	29.1	29
	4:10P	17	SSE20	38	39	52	37	39	55	40	41	44	53	-	41	55	37	53.3	39.3	40
27	9:30A	17	SSE30	53	54	63	53	53	65	56	56	57	63	-	55	65	53	63.7	54.3	53
	10:00A									Heaters darkened										
	4:30P	30	SSW15	59	59	69	58	59	70	62	62	63	72	-	61	72	58	70.3	60.0	-
	9:15P	25	WNW20	59	60	67	60	59	67	62	62	63	69	-	62	69	59	67.7	60.6	-
28	9:00A	10	W 40	51	50	54	51	50	54	54	52	51	56	-	52	56	50	54.7	51.4	-
Mar.										Test II.										
1	5:00P	-2	NNW20	2	1	3	2	3	4	5	6	4	4	-	5	6	1	3.7	3.4	
	10:00P	-12								Heaters Lit										
2	9:00A	-15	SSE9	34	34	47	33	34	52	38	36	41	49	-	37	52	33	49.3	35.1	
	4:30P	4	SE16	44	44	57	44	44	60	48	47	51	57	-	47	60	44	58.0	45.4	
	9:00A	12	SE19	56	55	67	56	55	69	58	58	60	67	-	57	69	55	67.7	56.4	

1/ Colder than minus 10 F°., lowest point on instrument.

Table No. 4

Corrected Air Temperatures

Car No. D BRE 74399
HEATER-UNDERSLUNG CHARCOAL - Test I. - Ash door closed
Test II.- Ash door replaced by screen

Date	Time	OST °F.	Wind	BBCL	BBNS	TBNS	BQCL	BQNS	TQNS	BDCL	BDNS	MDNS	TDNS	TL	BL	MAX.	MIN.	AVE. TOPS	AVE. BOTT.	LIQUID-OMETER TOP	LIQUID-OMETER BOTT.	INSIDE WALL
Feb.												Test I.										
25	10:00A	-19	Calm	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-19
	10:30A											Heaters lit										-20
	1:00P	-4	SSW8	-1/	-10	-10	-1/	-	-1/	-1/	-3	-1/	-1/	-1/	-1/	-3	-1/	-1/	-	-	-	-
	2:00P	0	SSW6	-8	-8	-6	-1/	-	-9	-1/	1	-7	-8	-7	-1/	1	-1/	-7.5	-	-	-	-
	3:00P	2	SSW6	-5	-5	-2	-9	-	-6	-10	3	-4	-5	-2	-1/	3	-1/	-3.8	-	-6	-12	-
	5:00P	1	SSE7	0	1	4	-3	-	1	-4	8	2	1	4	-8	8	-8	2.5	-1.0	-1	-12	-
	8:00P	-12	SSW9	5	7	8	3	-	5	1	14	6	5	6	-3	14	-3	6.0	4.5	4	-4	7
26	12:45A	-16	SSE8	11	15	9	9	-	11	8	23	13	11	12	4	23	4	10.8	11.7	8	2	-
	9:00A	-9	SSE19	13	15	16	11	-	13	12	22	15	13	14	8	22	8	14.0	13.5	12	8	17
	4:10P	17	SSE20	26	29	30	24	-	27	23	37	28	27	28	19	37	19	28.0	26.3	24	18	-
27	9:30A	17	SSE30	37	39	40	35	-	37	36	45	38	37	38	33	45	33	38.0	37.5	-	-	40
	10:00A											Heaters darkened										
	4:30P	30	SSW15	36	35	40	36	-	37	36	39	37	37	38	35	40	35	38.0	36.2	36	34	-
	9:15P	25	WNW20	34	33	39	35	-	34	35	37	35	35	36	34	39	33	36.0	34.7	35	34	-
28	9:00A	10	W 40	29	26	33	29	-	28	30	30	29	28	30	29	33	26	29.8	28.8	29	29	-
Mar.												Test II.										
1	5:00P	-2	NNW20	-1	-1	6	1	1	2	0	3	3	3	5	1	6	-1	4.0	0.7	5	1	
	10:00P	-12										Heaters lit										
2	9:00A	-15	SSE9	21	27	26	20	34	22	21	31	23	22	24	19	34	19	23.5	24.7	20	16	
	4:30P	4	SE 16	33	37	40	33	47	35	33	43	37	36	37	33	47	33	37.0	37.0	34	29	
3	9:00A	12	SE 19	45	50	51	45	57	47	46	55	48	47	48	44	57	44	48.2	48.9	44	40	

1/ Colder than minus 10°F., lowest point on instrument

Table No. 5

Corrected Air Temperatures

Car No. E BRE 74398
HEATER-END BUNKER CHARCOAL

Test I.

Date	Time	OST °F.	Wind	BBCL	BBNS	TBNS	BQCL	BQNS	TQNS	BDCL	BDNS	MDNS	TDNS	TL	BL	MAX.	MIN.	AVE. TOPS	AVE. BOTT.	LIQUID-OMETER TOP	LIQUID-OMETER BOTT.	INSIDE WALL
Feb.																						
25	10:00A	-19	Calm	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-1/	-14
	10:30A								Heaters Lit													-13
	1:00P	-4	SSW8	-7	-7	7	-	-6	8	-8	-3	2	8	11	-8	11	-8	8.5	-6.5	-	-	-
	2:00P	0	SSW6	-2	1	13	-2	-2	12	-4	0	8	13	16	-3	16	-3	13.5	-1.7	-	-	-
	3:00P	2	SSW6	4	5	19	4	4	17	1	6	13	19	23	2	23	1	19.5	3.7	20	-11	9
	5:00P	1	SSE7	12	14	28	14	13	27	10	16	23	28	33	11	33	10	29.0	12.9	28	-8	-
	8:00P	-12	SSW9	22	23	37	23	23	36	21	25	30	36	42	22	42	22	37.8	22.7	38	-4	25
26	12:45A	-16	SSE8	28	31	42	30	30	41	28	31	37	42	46	29	46	28	42.8	29.6	42	14	-
	9:00A	-9	SSE19	36	37	49	47	37	48	35	37	44	49	56	35	56	35	50.5	37.7	51	24	38
	4:10P	17	SSE20	48	51	62	51	50	61	47	50	58	62	66	48	66	47	62.8	49.3	63	33	-
27	9:30A	17	SSE30	62	64	74	63	63	73	60	62	69	73	78	61	78	60	74.5	62.1	-	-	65
	10:00A								Heaters Darkened													
	4:30P	30	SSW15	64	65	73	64	64	72	62	64	70	72	75	63	75	62	73.0	63.7	74	52	-
	9:15P	25	WNW20	62	62	67	62	61	67	60	61	64	66	70	62	70	61	67.5	61.4	70	54	-
28	9:00A	10	W 40	44	43	45	45	42	45	43	41	43	44	46	44	46	41	45.0	43.1	45	44	-

1/ Colder than minus 10°F., lowest point on instrument.

Table No. 6

HOURS REQUIRED FOR ALL OF THE BOTTOM LAYER POSITIONS AND THE AVERAGE BOTTOM LAYER POSITIONS TO REACH 40°F.

Car	Test I 4/ All Bot.	Test I 4/ Ave. of Bot.	Test II 8/ All Bot.	Test II 8/ Ave. of Bot.
A. Underslung Charcoal	- 1/	47	- 6/	- 9/
B. Alcohol	36	30	27	24
C. End Bunker Charcoal	33	30	16	15
D. Underslung Charcoal	- 2/	- 5/	29 7/	23 7/
E. End Bunker Charcoal	25 3/	24 3/		

1/ Minimum temperature was 36° after 47 hours.

2/ Minimum temperature was 32° after 47 hours.

3/ From about minus 14°.

4/ From about minus 20°.

5/ Average bottom temperature was 37.5° after 47 hours.

6/ Minimum temperature was 28° after 35 hours.

7/ With ash door replaced by screen.

8/ From about 2°.

9/ Average bottom temperature was 31.7° after 35 hours.

Table No. 7

FUEL CONSUMPTION IN TESTS I AND II

Car No.		Type of Heater	Fuel Consumption Test I 1/	Test II 2/
A.	IC50437	Underslung-Charcoal	52 lbs.	60 lbs.
B.	IC50470	End Bunker-alcohol	8.06 gals.	6.88 gals.
C.	IC50441	End Bunker-charcoal	45 lbs.	52 lbs.
D.	BRE74399	Underslung-charcoal	46 lbs.	67 lbs. 3/
E.	BRE74398	End Bunker-charcoal	50 lbs.	-

1/ 47½ hours

2/ 36 hours

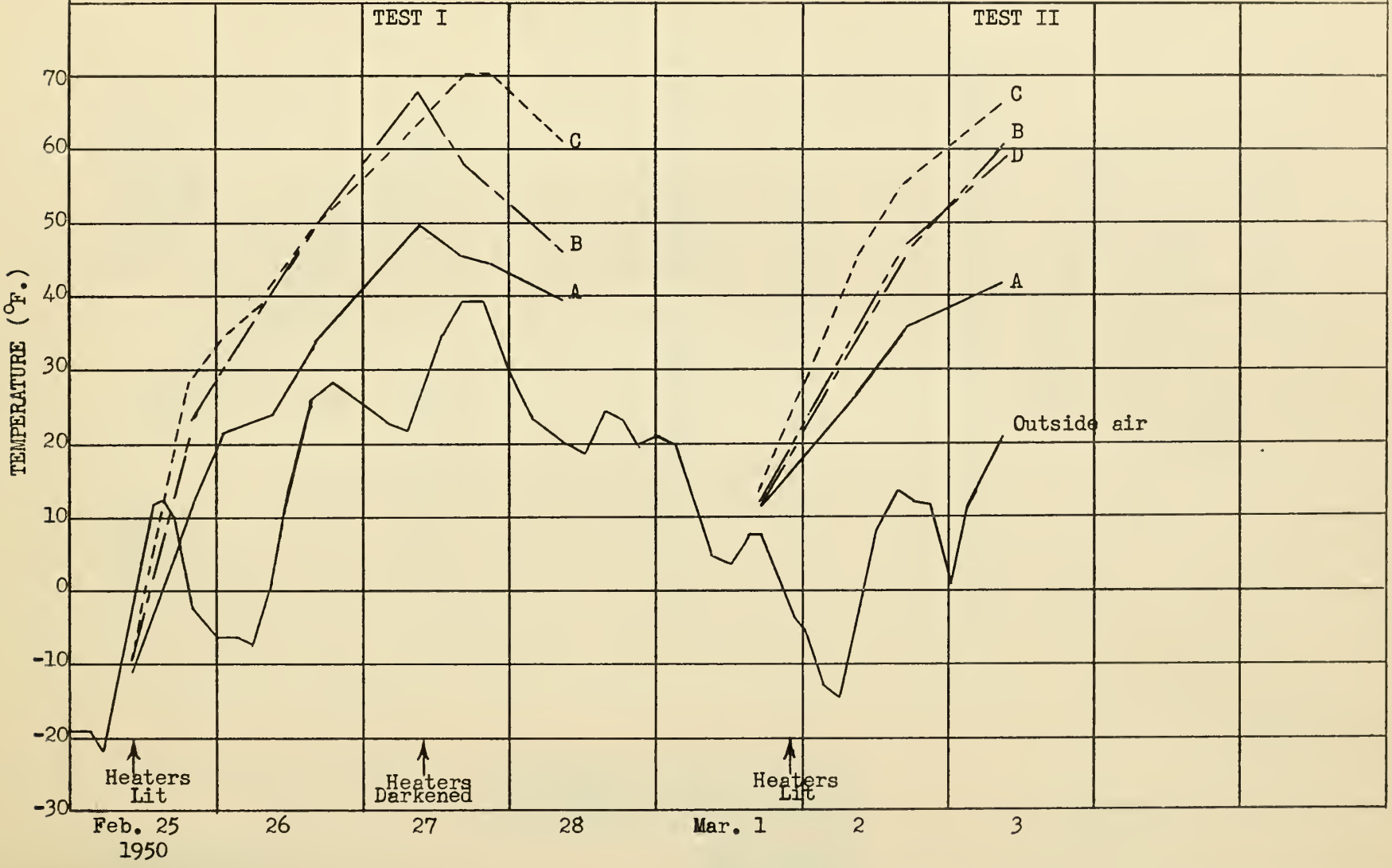
3/ Ash door replaced by screen

Table No. 8

COMPARISON OF LIQUIDOMETER AND RESISTANCE THERMOMETER READINGS

Date	Time	A IC 50437 Top Liq.	A IC 50437 Top Res. T.	A IC 50437 Bottom Liq.	A IC 50437 Bottom Res. T.	D BRE 74399 Top Liq.	D BRE 74399 Top Res. T.	D BRE 74399 Bottom Liq.	D BRE 74399 Bottom Res. T.	E BRE 74398 Top Liq.	E BRE 74398 Top Res. T.	E BRE 74398 Bottom Liq.	E BRE 74398 Bottom Res. T.
Feb.						Test I							
25	10:00A	- 1/	- 1/	- 1/	- 1/	- 1/	- 1/	- 1/	- 1/	- 1/	- 1/	- 1/	- 1/
	1:00P	- 1/	- 1/	- 1/	- 1/	-	- 1/	-	- 1/	-	11	-	-8
	2:00P	- 1/	-10	- 1/	- 1/	-	-7	-	- 1/	-	16	-	-3
	3:00P	-10	-7	-10	- 1/	-6	-2	-12	- 1/	20	23	-10	2
	5:00P	-6	-2	-7	-8	-1	4	-12	-8	28	33	-8	11
	8:00P	2	6	0	-1	4	6	-4	-3	38	42	-4	22
26	12:45A	8	15	8	8	8	12	2	4	42	46	14	29
	9:00A	13	15	14	12	12	14	8	8	51	56	24	35
	4:10P	24	27	22	22	24	28	18	19	63	66	33	48
27	9:30A	37	41	37	38	-	38	-	33	-	78	-	61
	4:30P	37	37	36	35	36	38	34	35	74	75	52	63
	9:15P	36	36	36	34	35	36	34	34	70	70	54	62
28	9:00A	30	30	32	30	29	30	29	29	45	46	44	44
Mar.						Test II							
1	5:00P	5	3	6	4	5	5	1	1				
2	9:00A	16	18	18	17	20	24	16	19				
	4:30P	26	29	26	26	34	37	29	33				
3	9:00A	32	34	34	32	44	48	40	44				

1/ Colder than minus 10°F., lowest point on instrument.

Fig. 1
AVERAGE BOTTOM LAYER TEMPERATURES DURING PREHEATING

Car A--Underslung charcoal heater.
Car B--Alcohol heater.
Car C--End bunker charcoal heater.
Car D--Underslung charcoal heater- ash door replaced by screen.